A Commentary on Comparative Morphology in Zingiberaceae

by

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Summary

A critical commentary is presented on the statement on comparative morphology of Zingiberaceae in Malaya published in Gard. Bull. Sing. Vol. 13, part 1 (1950), and a comparison made with the account of the family prepared by Bakhuizen for the *Flora of Java* Vol. 3 (1968) where terms are differently used and a different view of some genera (*Achasma* and *Amomum*) is maintained. An attempt is made to correct inconsistencies in the use of terms in both accounts, especially in relation to inflorescence-structure which is of basic importance in this family. Floral morphology is only considered in reference to the genera *Nicolaia* (mis-named *Phaeomeria* in Holttum 1950), *Achasma* and *Amomum*. Some comments are made on the status of some generic names but no proposals for change of the scheme of 1950 are made. A suggestion is made that experimental work might throw light on the structure of the condensed lateral cymes and in demonstrating the essential uniformity of structure of the inflorescence in the family. A plea is made that taxonomic statements on tropical plants should no longer be limited by the defects of dried specimens in European herbaria.

Introduction

In Singapore, during World-war II, I prepared a systematic study of the family Zingiberaceae in Malaya, based on all available records in the herbarium and library at the Botanic Gardens, on a considerable number of species in cultivation and native in Singapore island, and on inflorescences of many species preserved in alcohol, the majority collected, with elaborate field notes, by E. J. H. Corner. In this study I was greatly helped by the published works of Valeton, who also had (at Bogor) a wide range of living plants at his disposal and was able to see clearly structures which are not well preserved in dried specimens, and thus were not considered, or not understood, by herbarium botanists, notably J. G. Baker (1892) and K. Schumann (1904). After the war, in the years 1946-1949, I was able to examine a considerable number of living plants, some of the species not seen previously, in various parts of Malaya, and thus to improve my manuscript. I made drawings in all cases from living plants, with use of a camera lucida.

In the *Flora of Java* Bakhuizen expressed disagreement with my opinions (and those of Valeton on which mine were largely based), quoting a statement of mine which he believed to be contradictory. This led me to re-read what I wrote in 1950, and in so doing I found some inconsistencies in the use of terms. I have therefore decided to re-write my statement on morphology, especially of the inflorescence, to remove inconsistencies, and to show where I think Bakhuizen

has misunderstood not only my statement but also some specimens at his disposal. I judge that a large part of his difficulty was due to the fact that he had little or no living material available of most species. It is difficult or impossible to understand the detailed structure of the inflorescence of most Zingiberaceae from dried specimens unless such specimens have been specially prepared to demonstrate the significant characters. I have rarely seen specimens which do this effectively. However, the taxonomic study of tropical plants ought not to be limited by the imperfections of dried specimens.

Since Bakhuizen's publication, Burtt and Smith (1972) at Edinburgh have produced a most valuable critical report on the early history of taxonomic study of the family and on the significance of published generic names, accompanied by an excellent series of drawings. Burtt and Smith did not arrive at a conclusion as to the application of all the generic names, and in part such application depends on how genera are delimited. As I pointed out in 1950, I had no means of discovering the correct names for some of the groups I recognized as genera. I used the generic names which involved the least name-changes, and was chiefly concerned to characterize clearly the groups in question. In the present contribution I do not propose any changes in generic concepts, but I do offer some comments on the status of *Achasma* and *Nicolaia* (*Nicolaia* should replace the invalid name *Phaeomeria* of Holttum 1950).

Growth-habit

This is invariably sympodial, each new aerial stem arising from a bud at the base of the preceding stem. The new growth is first, for a short or longer distance, more or less horizontal and root-bearing, then erect. Erect leaf-bearing stems may have a terminal inflorescence, or flowering and leafy stems may be distinct from each other.

All leaves have a sheathing base, and a blade on a (usually short) stalk; the sheath is produced upwards above the attachment of the stalk into a ligule, so that the stalk appears to be a dorsal organ attached near the top of the sheath.

At the base of every stem, whether it bears fully developed leaves or not, are sheaths lacking leaf-blades. These are successively longer, and they often bear the rudiment of a blade just below the apex; the blade on the first blade-bearing sheath is small, later ones successively larger. The difference between leafy stems and flowering stems, where the two are different, lies solely in the fact that no blade-bearing sheaths are developed on the specialized flowering stems, which are covered with 2-ranked sheaths, often more numerous than those at the base of leafy stems but not otherwise different. In my work of 1950 I used the term *sheath* for these imperfect leaves. They might also be called cataphylls, but I prefer sheath because they represent exactly the sheaths of normal leaves. Bakhuizen calls them scales, but they are very different from the scale-like leaf-rudiments which cover the resting buds of dicotyledons. Exactly similar sheaths are found at the bases of new stems in many other families of Monocotyledons, but they are not always so conspicuously sheath-shaped as in most Zingiberaceae.

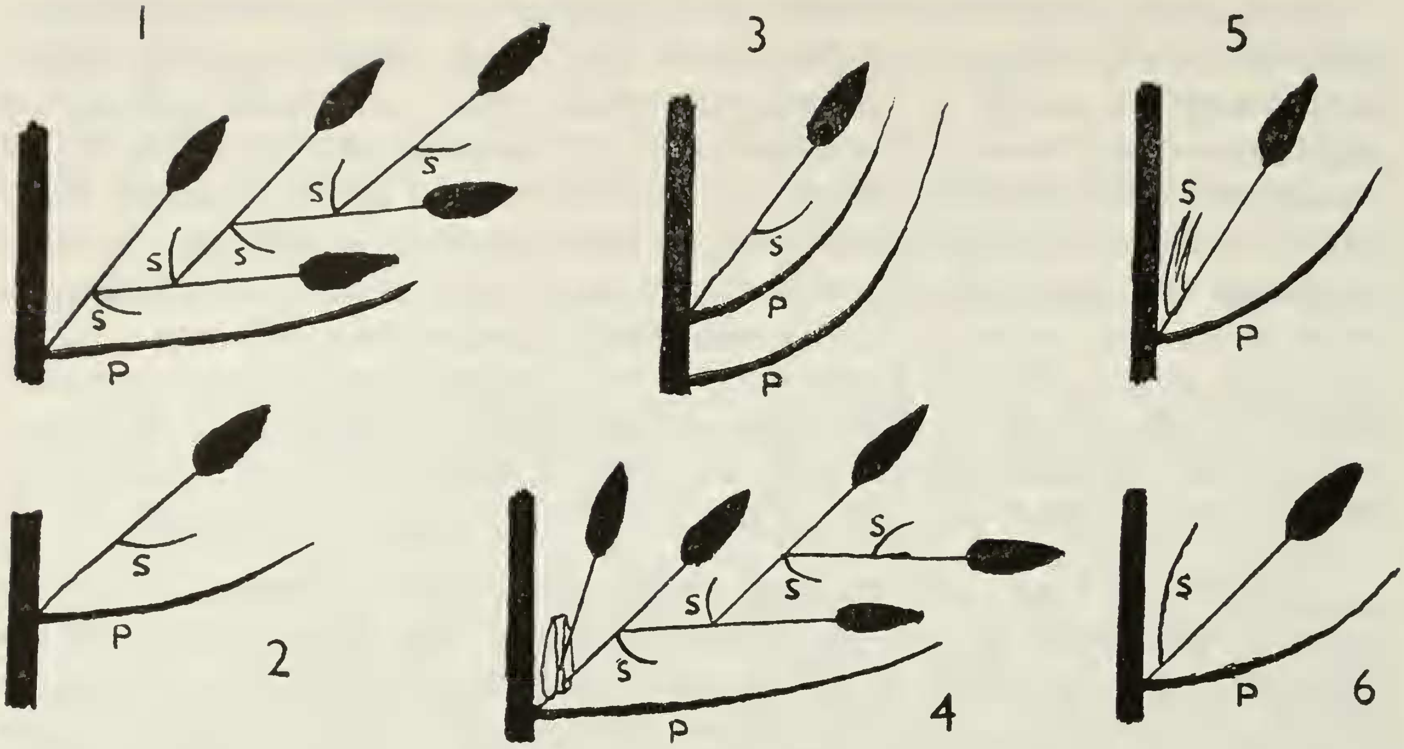
A flowering stem bears either 2-ranked complete leaves, or 2-ranked sheaths, below the flower-bearing part. The flower-bearing part bears bladeless sheaths *spirally* arranged (except in *Boesenbergia*, which needs more study). These are called the *primary bracts* of the inflorescence. If the inflorescence is at the top of a leafy stem, it is protected when young by the sheaths of the leaves on the lower part of the stem and emerges into free air only at a late stage of development. Correlated with this is the fact that the primary bracts of such an inflorescence are in many cases reduced (*Alpinia* and allied genera) or even absent; one may reasonably assume that the bracts have become reduced because their protective function is unnecessary. In cases where an inflorescence is borne on a short stem bearing short bladeless sheaths only, the primary bracts of the inflorescence are always well developed, and are exposed at an early stage of development.

The primary bracts, and the basal sheaths on all stems, whether flowering or not, are homologous, and *all* are essentially *leaves*. The primary bracts of the inflorescence are so called to indicate their position and function, not because they are essentially in any way different from ordinary sheath-leaves. In most inflorescences on short stems where the primary bracts are well developed, there is a leaf-blade rudiment just below the apex of each bract, just as on the sheaths at the base of a new stem.

At the transition from 2-ranked sheaths to spirally arranged primary bracts, on non-leafy flowering stems, there is often a gradual transition of *shape* between the uppermost 2-ranked sheaths and the lowest primary bracts. But the transition from the 2-ranked to the spiral arrangement is distinct, as can be seen from fig. 19A, 21A, 23A, 26A in Holttum 1950. The 2-ranked sheaths of the short flowering stems have no axillary buds, but the spirally arranged primary bracts normally bear flowers, or short cymose branch-systems, in their axils. There are however in Malaya and Java genera in which the lower primary bracts also are empty (*Nicolaia, Achasma, Hornstedtia*); in these cases the empty lower primary bracts are much larger than the upper ones (which have flowers in their axils) and completely enclose the latter. Bakhuizen (1968, p.51) states that he cannot see any difference between the 2-ranked sheaths and outer empty bracts, and therefore does not agree with my treatment of *Achasma* as a genus distinct from *Amomum*. I will revert to this matter later.

Inflorescence-structure

The spirally arranged primary bracts of an inflorescence bear in their axils either single flowers or more or less condensed monochasial cymes bearing several successive flowers. There is not a sharp distinction between the two conditions. In the genus *Catimbium* (Holttum 1950, p. 149) the same inflorescence may have 3-flowered cymes in the axils of basal primary bracts and only single flowers in the axils of upper primary bracts. As axillary monochasial cymes occur in other families of Monocotyledons, it is probable that this was the primitive condition in Zingiberaceae. The genera which have solitary flowers may thus be regarded as separate developments of reduction from the cymose state. In the genus *Zingiber* all species have solitary flowers except *Z. clarkei* King, which certainly belongs to the genus, as judged by the peculiar floral structure which occurs in no other member of the family.



TEXT-FIG. Diagrams showing branching of the inflorescence. In all cases the main axis of the inflorescence is shown bearing one bract which has in its axil a single flower or a monochasial cyme; P = primary bract, S = secondary bract. *1:* the condition of *Curcuma*, with an axillary cyme. The first secondary bract is at right angles to the primary bract, and successive secondary bracts each at right angles to the preceding one. *2:* the condition of *Amomum*, the axillary cyme reduced to one flower. *3:* the condition of *Hornstedtia* and *Achasma*, with outer larger empty primary bracts and smaller inner ones each with one axillary flower. *4:* the condition of *Scaphochlamys*. The first secondary bract is a 2-keeled prophyll backing the main axis, the rest as no. 1. *5:* the condition of *Kaempferia*, with deeply bilobed secondary bract backing the main axis, and one flower. *6:* the condition of *Zingiber*, with unkeeled secondary bract facing main bract, and a single flower.

The text-figure shows diagrammatically the postulated primitive type of inflorescence in Zingiberaceae, with an extended monochasial cyme in the axil of a primary bract. This cyme consists of a series of short axes each bearing one lateral bract and ending in a flower; a bud in the axil of the bract repeats the pattern. In this diagram for convenience, all branching is shown in the plane of the paper, but each bract appears to be at right angles to the preceding one, so that branching is not in one plane; the cyme is called a cincinnus. In practice, the cymes are in most cases so condensed (the successive axes being very short) that the exact relation of each bract to the preceding one is often difficult to see exactly. The situation is most easily observed in *Globba* and *Alpinia* (sensu Holttum 1950, p. 140); a condensed cyme of *Curcuma* is illustrated in Holttum 1950 fig. 4 B, C. The detailed development of these cymes needs more precise morphological study than I can attempt, especially in the case of *Scaphochlamys* (see below), by someone with access to ample fresh material.

The nomenclature of the bracts of the cincinnus needs clarification. In 1950, p. 7, I noted that these bracts could be called secondary bracts, to distinguish them from primary bracts, but that it was "more usual and more convenient to call them bracteoles", as Schumann (1904) did; however I was not consistent in this terminology, using both terms in later descriptions of genera and species. In the present statement all bracts on the cincinnus will be called *secondary bracts* only (see figure). They are developed on successive axes of the cincinnus and, though they are all regarded as having the same status, the later ones (at least when immature) are completely enfolded by the larger earlier ones when axes of the

cincinnus are very short, for which reason I used the term "inner bracteole" on at least two occasions for small later secondary bracts, a term taken up by Bakhuizen in a way not clearly explained (see below).

Thus the first short axis of the cincinnus, with a flower at its apex, is in the axil of a primary bract; later ones are all in the axils of secondary bracts. In 1950 (following Schumann) I sometimes used the term "floral bract", which in some cases referred to a primary bract (e.g. *Achasma*), sometimes to a secondary bract (e.g. *Geostachys*). In *Achasma* I used it to distinguish the inner primary bracts, each having a flower in its axil, from the outer empty primary bracts.

The condition of *Amomum* and other genera in which the cincinnus is reduced to one flower is shown in fig. 2. The condition of *Hornstedtia, Achasma* and *Nicolaia* is shown in fig. 3. In the latter case, the sterile primary bracts, attached at a lower level on the main axis than those which have axillary flowers, are larger and often completely cover the upper ones; the lower ones are thus in practice "outer" bracts and the upper ones "inner" bracts, but all, being attached to the main axis of the inflorescence, are *primary*.

In the genus *Scaphochlamys* (which does not occur in Java, and is thus not dealt with by Bakhuizen) there is a peculiar development in the first secondary bract, at the base of each cincinnus. This bract is 2-keeled, like the organ commonly called a prophyll in Gramineae, Cyperaceae, Marantaceae and other families (the German term is *adossierte Vorblatt*). In these families a 2-keeled prophyll occurs at the base of every new branch, whether large or small, and its back is usually curved to fit the parent axis against which it is compressed. So far as I know, such a 2-keeled prophyll does not occur elsewhere in Zingiberaceae except in a simplified form in *Kaempferia*. The first secondary bract in *Curcuma* is certainly lateral, not facing the primary bracts (Holttum 1950, fig. 4B). Schumann (1904, p. 14) mentions an *adossierte Vorblatt* in his species *Alpinia orchioides* and *A. pterocalyx* from Celebes, which I have not seen and do not understand from his descriptions.

In *Scaphochlamys* the 2-keeled prophyll functions as an additional (basal) secondary bract on the first axis of the cincinnus (fig. 4) and has either one or two flowers in its axil; it is comparable to the utricle in *Carex*, which is a prophyll in the axil of which a female flower is borne. The rest of the cincinnus in *Scaphochlamys* has normal secondary bracts, but they are smaller than the 2-keeled one which at first enfolds them all (Holttum 1950, fig. 10). For this reason I used the term "outer bracteole" (= outer secondary bract) for the 2-keeled bract, in the generic description of *Scaphochlamys*, and I believe nowhere else (not in the descriptions of individual species, where I used the terms first bracteole for the 2-keeled secondary bract, and 2nd, 3rd bracteoles for the rest). Again, Bakhuizen has taken up this term and has given it another significance.

In *Kaempferia* (Holttum 1950, p. 117) there is only one flower in the axil of each primary bract. The only secondary bract is more or less deeply bilobed, sometimes divided to the base (fig. 5); it appears to be comparable to the 2-keeled first secondary bract in *Scaphochlamys*, which is certainly a related genus. In *Zingiber* the sole secondary bract faces its primary bract, in the same way as the first secondary bract in *Scaphochlamys*, but it is neither keeled nor bilobed (fig. 6).

The above statement is necessary to clarify and correct my terminology of 1950, and also to point out how Bakhuizen has used some of the same terms confusedly in his opening statement on the family (1968, p. 41). He begins by stating that the main axis of the inflorescence is "provided with spirally arranged primary bracts bearing in their axil a lateral axis (cincinnus) with bracts of lower rank". Here it should be noted that a cincinnus is not a single axis but a branch-system. Bakhuizen then adds a parenthesis stating that the secondary bracts are taxonomically important, but he does not define them. One may however infer that they are *not* on the primary axis of the inflorescence; yet in his description of *Nicolaia* (see further comment below) he uses the term secondary bract for the inner (upper) bracts of the primary inflorescence axis.

Next Bakhuizen writes: "the whole complex of the usually numerous bracts which together with the branch-system and the floral bracts constitutes the inflorescence consists in the most complete condition of 3 elements: 1° primary bracts (bearing in their axil a lateral shoot, therefore sterile), often firmer or in other respects more conspicuous than the internal bracts, sometimes called involucre when they both distinctly surround the other ones and greatly differ in size and/or shape; as a rule the difference is not remarkable, in most cases the bracts gradually pass from one kind to another, which makes distinction almost impossible, especially in herbarium material".

As indicated in my own statement above on inflorescence-structure, primary bracts bear in their axil either a cincinnus (sometimes reduced to one flower) or *nothing*. Bakhuizen's statement that they bear in their axil a lateral shoot and are therefore sterile is to me unintelligible. His statement that inner bracts (e.g. in *Nicolaia*) are sometimes smaller than outer ones, with no sharp distinction is true, but they are all *primary bracts*.

He continues: "2° secondary bracts and those of lower ranks (outer bracteoles in the sense of Holttum; the outer ones sterile, the innermost fertile". I used the term "outer bracteole" once only, in describing the non-Javan genus *Scaphochlamys*, as above explained. The terms outer and inner "outer bracteoles" are not intelligible to me.

Next follows: "3° bracteole ('inner bracteole' in the sense of Holttum) in the axil of the innermost 'outer bracteole', entirely or partly surrounding the true flower, sometimes absent". So far as I can see, I only used the term inner bracteole in two cases (generic description of *Scaphochlamys*, and fig. 20C of *Hornstedtia leonurus*) to describe the smaller secondary bracts which are enfolded by earlier ones. They are not bracts of a third order, a concept never mentioned by me.

In the whole of the above discussion on the three types of bracts Bakhuizen fails to mention to which axes the three classes of bracts or bracteoles are attached, and therefore one cannot be sure what he means. One can only infer from his later use of the terms in generic descriptions which are discussed below.

Comments on Bakhuizen's Key to the genera (1968, p. 42).

As shown in fig. 1, there is a cyme, or branch-system, in the axil of each primary bract of several genera. In one sense, this may be regarded as a branch of the inflorescence, but the axillary branch-system does not duplicate the structure of the main axis. In Malaya there are species in the genera *Plagiostachys* (Holttum 1950, p. 160), *Alpinia* (p. 140) and *Languas* (p. 156) which have true inflorescence branches in the axils of lower primary bracts (see Holttum 1950 fig. 16); these branches are identical in structure with the apex of the whole

inflorescence (Holttum 1950 p. 6, last paragraph). But Bakhuizen, in his key to the genera, under "axis of the inflorescence branched" includes *Globba, Alpinia* and *Catimbium* where (in species of Java) the "branches" are not like the axis of the inflorescence but are cymes in the axils of primary bracts.

Apart from the ambiguity of the phrase "axis of the inflorescence branched", there are errors in the later part of the key. The characters given under *10 a* and *10 b* are mixed; they should be corrected as follows:

10 a. Bracts distichous, the upper ones flowering first; apex of bracteole entire; labellum often saccate, not strongly bilobed; axis of inflorescence distinctly elongate to short but not discoid .... 11. *Boesenbergia*

10 b. Bracts not distichous, lower ones flowering first; bracteole 1 (2-dentate or 2-partite) or 2 (unlobed, linear); labellum deeply bilobed, not saccate; axis of inflorescence discoid, flat or convex .... 10. *Kaempferia*

The characters under *11 a* and *11 b* are also confused. *11 a* should be corrected to "bracteoles tubular"; *11 b* needs the addition "bracteoles with free margin".

The genera Hornstedtia, Nicolaia and Achasma

Malayan species of these genera, so far as then known, were all included in *Amomum* by Baker (1892, pp 233-243) but mixed in his various subgenera. These genera all differ from *Amomum* by the fact that the lower primary bracts are larger than the later ones, which they enfold; these outer primary bracts are empty and serve for protection of the later-formed parts of the inflorescence. The three genera also differ from *Amomum* in floral structure. The basic pattern of the inflorescence is shown in fig. 3. As pointed out by Valeton (1904) and as shown in Holttum 1950 fig. 21, 22, 23, the floral structure in *Nicolaia* and *Achasma* is identical, and distinct from any species of true *Amomum*, but Bakhuizen maintains *Nicolaia* as a distinct genus and unites *Achasma* to *Amomum*. He distinguishes *Nicolaia* from *Amomum* in his key to the genera (1968, p. 42, 43) solely by the fact that in the former the inflorescence is on an erect peduncle, whereas in *Amomum* the peduncle is short and wholly or almost wholly subterranean. But in *Nicolaia solaris* (Bl.) Horan. the inflorescence is sometimes only just raised above the ground (van Steenis 1972, pl. 57, fig. 5), and in *N. hemisphaerica* (Bl.) Horan. (Bakhuizen 1968 p. 63) the peduncle is only $3\frac{1}{2}$–12 cm long. Thus Bakhuizen rates this single, not very distinctive character as of greater importance than the distinctive and uniform characters of floral structure. The coloured illustrations published by van Steenis (1972, pl. 57) show the great similarity between *N. solaris* and *Amomum* (Achasma) *coccineum* (Bl.) K. Schum. in general aspect of the inflorescence quite apart from details of floral structure.

Bakhuizen unites *Achasma* with *Amomum* because he cannot see, from herbarium specimens, that there is a clear distinction between the "outer stalk-scales [i.e. 2-ranked sheaths of the peduncle], involucral leaves [i.e. empty outer primary bracts] and bracts, which pass into one another in dried specimens". He states that in Holttum 1950, p. 183, I wrote that "involucral leaves and bracts pass into one another". What I did write was: "involucral bracts 2–8, much wider than the inner floral bracts ... Floral bracts with one flower to each, the

inner ones narrow, the outer often wider and showing a transition to the involucral bracts". The "floral bracts" of this statement are the inner primary bracts which bear flowers in their axils and by this fact are distinguished from the empty outer involucral primary bracts. In the case of *Nicolaia*, which has an indentical inflorescence structure, Bakhuizen himself notes (1968, p. 62) that there is a gradual change from involucral bracts to the inner ones which have axillary flowers.

Bakhuizen further confuses the situation by using the term secondary bract for the inner primary bracts of *Nicolaia* which have axillary flowers, but in his description of *Amomum coccineum* (Bl.) K. Schum. (which belongs to *Achasma* and was so placed by Valeton) he does not. The basic distinctions between *Nicolaia* + *Achasma* and *Amomum* are that in the former the filament of the stamen and the base of the labellum are united in a separate tube beyond the apex of the corolla-tube, and the anther is massive, more or less cleft at the apex, never crested. In the key which is combined with the specific descriptions in *Amomum*, Bakhuizen (1968, p. 55, para. 8a) fails to mention these as distinctive characters; in his generic description of *Amomum* he includes "labellum ... usually not adnate to the filament, sometimes partly so", not indicating that the latter condition applies solely to *Achasma*, nor does he mention the distinctive character of the anther of *Achasma*. In his description of *Nicolaia* he does mention these identical distinctive characters. Thus he disguises the identity of floral structure in *Nicolaia* and *Achasma*. To the above distinctions may be added two others, mentioned by Valeton but not by Bakhuizen: in *Nicolaia* and *Achasma* the base of the labellum is rolled spirally inwards on withering (a conspicuous character on living inflorescences) and in both genera several flowers open simultaneously, forming a circle with the labella radiating outwards (van Steenis 1972, pl. 57, fig. 2, 5).

In my judgement, *Achasma* and *Nicolaia* should be united. The only differences are: (*a*) length of peduncle, (*b*) length of labellum, (*c*) fewer involucral bracts in some species of *Achasma*, (*d*) outer involucral bracts spreading in *Nicolaia*, not in *Achasma* (where they are prevented by the earth from spreading). These are relatively trivial characters, and none of them are very sharp. This has been noted above for the peduncle of *Nicolaia solaris*. *Amomum maingayi* Bak., which Schumann transferred to *Phaeomeria* (Holttum 1950, p. 180, fig. 21) is like *Nicolaia* in having a fairly long erect aerial peduncle, but its involucral bracts do not spread horizontally and its labellum is about intermediate in length between typical *Nicolaia* and typical *Achasma* (Valeton 1904, p. 96, suggested that such intermediates might occur.). Thus in characters *a*, *b*, and *d* there is no sharp distinction between the two genera, and in the floral characters mentioned there is quite uniform identity. As regards number of involucral bracts, in *Achasma* they are usually sufficiently numerous to give a quite distinctive aspect in living plants (which are very abundant locally in Malaya, though apparently not in Java) as shown in Holttum 1950, fig. 23A). But in two Malayan species which have only 1–3 flowers in an inflorescence the number of involucral bracts is fewer, sometimes only two. It seems to me possible that plants described as *Achasma pauciflorum* and *A. subterraneum* (Holttum 1950, p. 187) are only depauperate (or immature) forms of *A. macrocheilos* and *A. sphaerocephalum* respectively, with which species they agree in form of corolla and other details.

There is another complication to this situation, not mentioned in my work of 1950 nor by Bakhuizen, namely the existence of species in the eastern part of Malesia which were included by Valeton in the genus *Geanthus* (Valeton 1913, pp 930–936, pl. 162–166; 1914, pp 43, 55–58). These species have a floral structure as in *Nicolaia* and *Achasma* but have few or no involucral bracts. The original publication of the generic name *Geanthus* by Reinwardt (see Burtt and Smith 1972, p. 215) included species of *Hornstedtia, Achasma* and *Nicolaia. G. coccineus* (Bl.) Reinw. is recognized as the type of *Geanthus; Achasma* Griff., a later name, is certainly a synonym. But there is a much earlier generic name which certainly applies to the Malayan species *Achasma megalocheilos,* namely *Etlingera* Giseke (1792) based on a long and detailed description of *Amomum littorale* Koenig (1783; for references see Burtt and Smith 1972). It seems to me clear therefore that the species which I included in *Achasma* and *Phaeomeria* in 1950 should be transferred to the genus *Etlingera.* The problem is whether *Geanthus* sensu Valeton 1913 and 1914, which does not include an original species of *Geanthus* Reinw., should also be included.

Of the three Malayan genera recognized by me in 1950 which have large involucral bracts, *Hornstedtia* remains to be considered. Ridley (1924) included *Achasma* sensu Holttum 1950 in *Hornstedtia* because of the obvious similarity of the form of the inflorescence (which he could see from living plants). But the structure of flowers in the two genera (which Ridley did not observe carefully) is different, and they should certainly be separated. On this I have no new information, but I again call attention to the aberrant species *H. leonurus* (Holttum 1950, p. 167), which should perhaps be made the type of a new genus; excluding *H. leonurus, Hornstedtia* is very sharply distinct from *Achasma.* Bakhuizen's generic description of *Hornstedtia* (1968, p. 58) includes the following: "each involucral bract ... bearing in its axil (very) numerous secondary bracts (floral bracts), the outer ones of which (inner involucral bracts) still resemble the involucral bracts, the inner ones narrower". The fact is that all involucral bracts are *empty.* Again, as in *Nicolaia,* he refers to the bracts which subtend flowers as secondary, whereas they are primary bracts, attached to the primary axis of the inflorescence.

Alpinia and allied Genera.

As regards the genera of the *Alpinia* alliance in Malaya, Burtt and Smith point out that according to the present Code the name *Alpinia* should strictly apply to the species I have included in *Languas,* and that there is an earlier name which should replace *Catimbium.* But it is still not clear what name should replace *Alpinia* sensu Holttum 1950; this was the reason why I retained the name *Alpinia* for them (all but one had already names in *Alpinia*) and used *Languas* for *L. galanga* and its near allies. In correspondence, Mr Burtt has pointed out to me the great similarity between the flowers of *Alpinia* (*Languas*) *galanga* (L.) Willd. and *Alpinia allughas* (Retz.) Roscoe of Ceylon (Burtt and Smith 1972, fig. 3A, 3B); *A. allughas* clearly belongs to *Alpinia* sensu Holttum 1950, on account of its funnel-shaped secondary bracts. Mr Burtt suggests that *Languas* and *Alpinia,* of my arrangement of 1950, should be united, pending further study of non-Malayan species; but I still think that my *Alpinia* represents a species-group distinct from *Languas,* and that recognition of a distinct genus *Languas,*

though in an illegitimate sense, is the simplest solution for the present situation, recognizing that there are extra-Malayan species which need further study and might indicate a different concept or the use of another generic name. Merely observing the rules of the Code does not ensure that one writes rational taxonomy.

Experimental investigation of inflorescence-structure

D. L. Smith (1967, p. 25) treated the developing inflorescence of a species of *Carex* with kinetin, and thereby induced the further development of a partial inflorescence which is normally reduced to one female flower. It occurs to me that treatment of young inflorescences of species of Zingiberaceae which have solitary flowers might induce the development of a branch of the cincinnus in the axil of the secondary bract which in such cases is normally empty, though no doubt experimental technique would be difficult in *Achasma* and other genera with tightly over-lapping primary bracts. If such an experiment were successful, it could throw new light on the basic inflorescence-structure in the family. Such treatment of *Kaempferia* and *Zingiber* might demonstrate that their secondary bracts are homologous with the 2-keeled first secondary bract in *Scaphochlamys;* in any event, a careful study of the development of cincinni in the group of genera called Hedychieae in my paper of 1950 is very desirable.

I have the impression that a detailed comparison of inflorescence-structure in Monocotyledons as a whole might throw much light on taxonomic problems, and that experimental work like that of D. L. Smith could be of much help in understanding relationships (perhaps in Dicotyledons also, but that is beyond the scope of my detailed knowledge). In most general taxonomic works there is detailed description of floral and fruit structure but very cursory information on branching of inflorescences. McClure (1934) was the first person to show that the bamboos of Asia show two distinct types of inflorescence-branching. Until Lane's paper of 1955 no description had ever been published of the peculiar branching of the inflorescence in *Orchidantha,* which is of much interest in relation to that of other families in Zingiberales (see Holttum 1970). Other examples might be quoted.

As Valeton showed (1904) a clearly defined classification of Zingiberaceae is impossible without reference to inflorescence-characters; Schumann's attempt (1904) to define genera on floral characters alone led to much confusion. I found that he had species of both *Boesenbergia* and *Scaphochlamys* in his genus *Gastrochilus* and also in *Kaempferia,* and some species of *Scaphochlamys* in *Curcuma.* Hutchinson's latest account of the family (1973) is still based mainly on Schumann (little changed by Loesener in 1930) and incidentally retains Ridley's "genera" *Conamumum* and *Carenophila.* Ridley's descriptions of these were so inaccurate that Schumann placed *Conamumum* and Loesener the later-described *Carenophila* in the tribe Hedychieae, whereas examination of the type specimens in Singapore shows that they belong to Alpinieae. *Conamomum* in Ridley 1924 consists of two species of *Amomum* and one of *Geostachys;* the sole species of *Carenophila* also belongs to *Geostachys.* The full classification of the family will not be understood until much further study, from fresh material, of the species in the eastern part of the Malayan region has been undertaken. It is very gratifying to know that such study is being pursued by Mr Burtt and Miss Smith at Edinburgh, but there is much still to be done.

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